An Ecosystem Service Approach to Inform Reactive Nitrogen Management in the Lower Yakima River Basin, Washington.

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Abstract:

Spatially explicit ecosystem service valuation (ESV) allows for the identification of the location and magnitude of services provided by natural ecosystems to human activities along with a measure of their significance based upon economic valuation. While this provides an important function in terms of land use management, the connection between the values of ecosystem services, sensitivity to nitrogen loading and nitrogen load estimates is unexplored within both the GIS-based ESV literature and among research on nutrients and ecosystem services. This research combines a GIS-based, value transfer approach to map ecosystem services in the Lower Yakima River Basin (LYRB), Washington, USA, along with estimates of nitrogen loading to identify how nitrogen management may affect ecosystem services in the basin. This analysis combines values of ecosystem services with estimates of nitrogen loading and identifies subwatersheds and specific parcels within a Ground Water Management Area (GWMA) most susceptible to reductions in ecosystem services due to excess nitrogen loading. Based on the benefit transfer analysis, wetlands and forested areas have disproportionately high values of ecosystem services when compared to their land area in the LYRB, while pasture and cultivated crops contribute much less to the total value of ecosystem service flows in proportion to the total area in the LYRB. Across the study area estimated nitrogen loads are strongly driven by the location of confined animal feeding operations (CAFOs) and cultivated crops. The location and hydrologic setting of these land uses in relation to valuable ecosystem services is a critical component to understanding the potential changes in ecosystem services. Areas of particularly high nitrogen loading and high ESV, may highlight specific areas for achieving immediate success in increasing or maintaining ecosystem services through appropriately focused regulatory mechanisms. The land cover analysis however, completely neglects the values and importance of subsurface processes and ground water resources in ecosystem service assessment, and therefore an econometric model is applied to estimate willingness to pay (WTP) to maintain given nitrate levels in private wells. Through the incorporation of WTP estimates for ground water quality, a more complete economic and ecological perspective on the effects of landscape N loading in the study site is highlighted.

Further economic valuation data on specific land cover types and the value of ground water quality, whether from primary studies or meta-analysis, is needed to refine relative measures of ecosystem service values and more confidently describe these values in specific dollar amounts. Additionally, limits in spatial data resolution may contribute to errors in location and magnitude of ecosystem services, and is an area in need of further development. Despite these potential limitations, this analysis highlights a promising direction for combining spatially explicit ecosystem service valuation with nutrient loading data to identify the location and magnitude of effects on ecosystem services from management practices.